

Claims

1. The invention relates to a method for determining the humidity (ψ) and/or density (ϱ) of a dielectric material in a resonator filled with the material, comprising a sender and a receiver, characterized in that
- 5 - the sender emits a signal,
- a resonance curve of the filled resonator is swepted, wherein appropriate signal strength values (U_i) of the receiver signal are measured at respective different frequencies (f_i),
- 10 - the resonant frequency (f_{rm}) and the bandwidth (BW_m) are determined for the filled resonator from measured points (f_i/U_i) and
- the humidity (ψ) and/or density (ϱ) of the material are calculated by solving a second system of equations (G2) comprising the resonant frequencies (f_{r0}, f_{rm}) and bandwidths (BW_0, BW_m) of the empty and of the filled resonator and
- 15 known calibration coefficients ($a_{f_{r1}}, a_{f_{r2}}, b_{f_{r1}}, b_{f_{r2}}, c_{f_{r1}}, c_{f_{r2}}, a_{f_{bw1}}, a_{f_{bw2}}, b_{f_{bw1}}, b_{f_{bw2}}, c_{f_{bw1}}, c_{f_{bw2}}$) of the resonator.
2. Method according to claim 1, characterized in that, from the points (f_i/U_i) for determining the bandwidth (BW_m) of the filled resonator, either the
- 20 quantities resonant frequency (f_{rm}), resonator quality (Q_m) and resonance maximum (U_{rm}) are determined and the bandwidth (BW_m) is calculated therefrom, or cut-off frequencies (f_{am}, f_{bm}) are determined and the resonant frequency (f_{rm}) and the bandwidth (BW_m) are calculated therefrom.
- 25 3. Method according to claim 1 or 2, characterized in that a lower threshold value (U_a) is calculated and a second sweeping pass with smaller step sizes is

performed in that range in which the signal strength values (U_i) are higher than the threshold value.

4. Method according to claim 1, 2 or 3, characterized in that sweeping the resonance curve is performed in equally spaced steps (Δf_1 , Δf_2).

5. Method according to one of the preceding claims, characterized in that the sender is operated using a constant strength.

6 Method according to one of the claims 2 to 5, characterized in that the cut-off frequencies (f_a , f_b) of the resonator are determined by

- determining the point (f_i/U_i) having the highest receiver signal strength value (U_{\max}), and, starting from this point, calculating a threshold value (U_g) and

- determining two proximate points (f_i/U_i , f_{i+1}/U_{i+1}) for positive and negative slope sections, the signal values (U_i , U_{i+1}) of these points lying below and above the threshold value (U_g), respectively; and by calculating first and second cut-off frequencies (f_a , f_b) therefrom by respectively interpolating between the proximate points (f_i/U_i , f_{i+1}/U_{i+1}).

7. Method according to claim 6, characterized in that the threshold value (U_g) corresponds to an attenuation of 3 dB in relation to the highest signal value (U_{\max}).

8. Method according to one of the claims 2 to 5, characterized in that the quantities resonant frequency (f_r), resonator quality (Q) and resonance maximum (U_r) of the resonator are determined by

- arbitrarily and/or randomly selecting three points (f_i/U_i) and solving a first system of equations (G1) for these quantities (f_r , Q , U_r), the system consisting of three equations of the an analytic resonance curve valid for the three points (f_i/U_i).

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9. Method according to one of the claims 2 to 5, characterized in that the quantities resonant frequency (f_r), resonator quality (Q), resonance maximum (U_r) of the resonator are determined by

- arbitrarily and/or randomly selecting a set of points (f_i/U_i) whose number is an integer multiple of three and is at least six, and splitting up the point set into three equally sized groups (M_1 , M_2 , M_3),

- for each combination of three points (f_i/U_i), wherein each point (f_i/U_i) comes from a different group (M_1 , M_2 , M_3), solving a first system of equations (G1) for these quantities (f_{rk} , Q_k , U_{rk}), the system consisting of three equations of the analytic resonance curve valid for these three points (f_i/U_i), and,

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- for each quantity (f_r , Q , U_r), creating the average of the values (f_{rk} , Q_k , U_{rk}) calculated at the combinations.

10. Method according to claim 8 or 9, characterized in that, as a condition for arbitrarily and/or randomly selecting the points (f_i/U_i), the signal value (U_i) of a point (f_i/U_i) to be selected is higher than the highest signal value (U_{max}) attenuated by 3 dB.

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11. Method according to one of the preceding claims, characterized in that the second system of equations (G2) describes, in a good approximation, the correlation of humidity (ψ) and density (ϱ) on the one hand, with the variation of resonant frequency (f_r) and resonator quality (Q) or with the variation of

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resonant frequency (f_r) and bandwidth (BW) on the other hand, in a predefined range of humidity and density.

5 12. Method according to one of the preceding claims, characterized in that the second system of equations (G2) is non-linear.

13. Method according to one of the preceding claims, characterized in that the sweeping by means of the sender is performed up to the microwave area.

10 14. Method according to one of the preceding claims, characterized in that voltage values or current values of the receiver are used for measuring the receiver signal.